DOCUMENT RESUME

ED 262 236 CE 042 649

TITLE Industrial Mechanics. Subject Matter Update 1986-87.
INSTITUTION Oregon State Dept. of Education, Salem. Div. of Vocational Education.
PUB DATE 85
NOTE 21p.; For related documents, see CE 042 647-652.
PUB TYPE Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Basic Skills; Course Content; *Curriculum Development; Educational Objectives; *Education Work Relationship; Employment Opportunities; Employment Projections; Equipment; Job Skills; *Machine Repairers; *Mechanics (Process); Occupational Clusters; *Program Improvement; *Relevance (Education); Secondary Education; Skill Development; State Curriculum Guides; Statewide Planning; Trade and Industrial Education; Vocational Education
IDENTIFIERS Oregon

ABSTRACT

This publication recognizes the constantly changing requirements of industrial mechanics occupations and varying conditions for employment opportunities. It addresses the goal of relevance in education by enabling the educator to make timely adjustments in the subject matter of the industrial mechanics curriculum. There are six sections in this publication, each of which can assist the vocational education teacher in evaluating and improving existing materials and in developing new subject matter. The sections cover the following topics: (1) program goals in the industrial mechanics cluster, (2) changing industry trends and trade practices, (3) employment trends in industrial mechanics, (4) equipment needs, (5) subject matter changes, and (6) essential learning skills. By using this information, the teaching staff may achieve higher levels of classroom productivity--a productivity that not only recognizes future needs but also fosters strong linkages between educators, students, and the associated industries. (This update represents the opinions of industry people and is not the result of a detailed analysis of occupations.) (KC)

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Industrial Mechanics

Division of Vocational Education
Oregon Department of Education, Salem

Verne A. Duncan
State Superintendent
of Public Instruction

Subject Matter
Update
1986 - 87

Industrial Mechanics

1985

Oregon Department of Education
700 Pringle Parkway SE
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Foreword

In keeping with the theme of excellence in education as established by the Oregon Action Plan, the Department of Education is enthusiastically committed to strengthening its ability to provide education that is relevant and applicable. An effective vocational education program will meet the needs of students and, at the same time, meet the goals of the State's education system.

This publication, Subject Matter Update—1986-87, recognizes the constantly changing requirements of industry and the varying conditions for employment opportunities. It speaks to the goal of relevance in education by enabling the educator to make timely subject matter adjustments.

There are six sections in this publication, each of which assists the vocational education teacher in evaluating and improving existing material and in developing new subject matter. By using this information, teaching staff may achieve higher levels of classroom productivity—a productivity that not only recognizes future needs but also fosters strong linkages between educators, students, and the associated industries.

These updates represent the opinions of industry people and are not the result of detailed analyses of occupations. The educator should regard them as a tool for the review of program subject matter. For further information, contact the Division of Vocational Education, 378-2127.

Verne A. Duncan
State Superintendent
of Public Instruction

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Introduction

Vocational Education — Responding to the Future

Educators must deal with a great many issues during the remainder of this decade if vocational education is to respond to the needs of students as well as business, industry and labor. The Oregon Action Plan for Excellence in Education clearly calls for schools to provide a balanced and comprehensive curriculum for each student. Vocational education is an important part of that curriculum. As such, it is critical that programs in vocational education strive for excellence.

The most important component of excellence in vocational education is clearly the curriculum—what students are taught. Thus, it is essential that subject matter be kept as current as possible. As industries change directions, new job skills become necessary. Gradually, new occupations emerge as industry moves to incorporate new development technology.

There must be a system in place to capture this change and transform it into updated curriculum in vocational programs. It is not enough to say that five years from now there will be these new occupations requiring these kinds of skills and knowledge. Rather, curriculum should be evaluated frequently based on the best advice of people who work in those industries and occupational areas so that five years from now, students will be competitive in the labor market.

Meeting the Challenge

This is the concept that the Oregon Department of Education's Division of Vocational Education feels is essential to address. After all, subject matter really defines each occupational program, dictating facility and equipment needs, the skills of teachers and even the composition of program advisory committees. The first step then, is the formation of professional groups from industry and labor who have special knowledge about the needs and trends in their fields. Their task is to review program and course goals, and to give their views of industry changes and labor market needs. Through a grant from the Department of Education to Oregon State University, these technical committees will provide teachers with updated information every two years so that local programs can continually meet the challenge of excellence.

About the Technical Committee

The Oregon Department of Education and Oregon State University considered the staffing of the technical committee a critical factor for the success of this project. The individuals selected have outstanding records of achievement and significant prior working experience in the occupations covered in the Industrial Mechanics Cluster Program.

Larry Abney
Consultant
Heating and Cooling
Sherwood

Bob Gamache
Consultant
Manager—GM Training Center (Retired)
West Linn

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GM Training Center
Tigard

Mike Ward
Training Manager
Halton Tractor
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Wayne Wendlad
Owner and Manager
Power Equipment Systems
Salem

The Subject Matter Updates for Vocational Education Cluster programs are a joint project of Oregon State University and the Oregon Department of Education.

Program Goals in the Industrial Mechanics Cluster

The technical committee members reviewed the existing Industrial Mechanics Vocational Cluster Program goals and unanimously determined that all of the goals remain important to the occupations within the field. The eleven established goals are listed below.

Students who complete the Industrial Mechanics Program

1. Will know and be able to apply techniques that promote safety consciousness on the job.
2. Will be able to use standard industrial mechanics tools.
3. Will be able to operate and service internal combustion engines.
4. Will be able to select from a variety of available standard measuring tools used by industrial mechanics, and use these according to specific job needs.
6. Will be able to service electrical systems and maintain them in working order.
7. Will be able to operate and repair fluid power systems, and maintain these systems in working order.
8. Will know and be able to apply job-readiness skills.
9. Will be able to operate, service and repair machines and equipment.
10. Will know and be able to apply concepts and principles from mathematics, sciences, and communications to industrial mechanics.
11. Will know and be able to apply entrepreneurship skills to industrial mechanics.

Of the eleven goals, the committee members unanimously selected goals 1, 2, 8 and 10 as the most significant. Additionally, the committee determined that adherence to goals 8 and 10 is crucial to serving the purpose of the Industrial Mechanics program. Although students involved in active chapters of the Vocational Industrial Clubs of America (VICA) learn job readiness skills, the committee expressed concern that all of the job readiness skills might not be stressed. The committee also suggested that basic mathematics and science skills be emphasized more in classroom and shop work.

Changing Industry Trends and Trade Practices

Industry Trends

The industries that employ graduates of Industrial Mechanics programs are undergoing major changes, some of which may create new job opportunities in the future. Many will require a more sophisticated set of skills and knowledge.

The committee identified four trends that will have the greatest impact on the Industrial Mechanics curriculum.

1. **Increasing use of electronic components and circuits.** For several years, automobile manufacturers have installed microprocessors into their products. More and more, the mechanic needs an understanding of electronics in order to properly diagnose problems in recent model automobiles. Electronic components are also being used in heavy equipment such as automatic grade control, electronic transmission shifting and electronic governors. Clearly, the study of electricity and the fundamentals of electronics are becoming an increasingly important area within Industrial Mechanics.

2. **More emphasis on the use of hydraulics and pneumatics.** More and more, power equipment is being developed and manufactured to replace hand tools normally used for the home trade and, in some cases, for commercial operations as well. This transition has translated into an increased number of small air-cooled, engine-driven devices introduced to the market place, which drive or use hydraulic and/or pneumatic subsystems in their operation. Another emerging area is the use of servo and proportional hydraulic valves in automated manufacturing. Additionally, industry considers pneumatic logic very important in the case of moving parts fluid control. It has been used as a very attractive alternative to electric and electronic control.

3. **Widespread use of computers for supply inventory and vehicle diagnostics.** This field will expand as engine control circuits become more complex. The majority of committee members felt that all students should have a basic typing course to help them use the computer. Self-paced lessons offered by major software houses and suitable for secondary school students would also provide an excellent orientation to computers.

4. **Increased specialization to carry out complex diagnostic procedures.** Mechanics will need to update their skills regularly in order to keep up with the changing technology. Therefore, an ability and interest in learning must be fostered in the classroom. To remain competitive in fields of changing technology, the worker may have to return frequently to the classroom.

Changes in Trade Practices

Work in the industrial mechanics area is rapidly changing. What was an acceptable practice just a few years ago is often incorrect today.

The Technical Committee identified eight changes in trade practices that will have a major impact on mechanics in the years to come.

1. **Less engine rebuilding**. Independent automotive repair shops and new car dealer agencies are doing less engine rebuilding. Increasingly, it is becoming more economical for these facilities to install factory-rebuilt engines or short blocks. This trend also applies to other major auto components such as transmissions, carburetors, and drive line parts. Mechanics are doing more diagnosing and removing and replacing components.

2. **More emphasis on safety**. Shops are stressing worker safety not only to meet OSHA regulations and insurance requirements, but because good safety practices prevent personal injuries and losses in worker productivity. Even though safety has been paramount in industry for years, new procedures must be developed to keep pace with changing technology. Shop supervisors are undertaking an increasing role to meet these new requirements to maintain worker safety.

3. **Knowledge of environmental regulations necessary**. Mechanics need to be familiar with regulations regarding the disposal of used oil and cleaning solvents. These wastes cannot be dumped into municipal sewage systems. Mechanics need to realize the consequences of removing pollution control devices and the dispersing of leaded gasses into automobiles requiring unleaded fuel.

4. **More small-engine repair**. In the field of small engines, many repair shops are going back to the rebuilding of the expensive, industrial quality, air-cooled engine.

5. **More diesel engines used**. Knowledge of diesel engines and related systems (hydraulics, drive mechanisms) is needed by people in the industrial mechanics field.

6. **More problem solving skills**. Mechanics need to have more problem-solving skills to deal with the complexities of advancing technologies such as electronic and vacuum operated circuits.

7. **Air-conditioning more common**. More vehicles—heavy equipment, farm implements and automobiles—are equipped with air-conditioning. Mechanics need to have an understanding of air-conditioning principles.

8. **Higher expectations of mechanics**. Students need to be aware of how the trade has changed in terms of work environment, type of work and pay. Mechanics today are well-paid technicians. Their success is often based on the ability to follow complex diagnostic procedures.

Employment Trends in Industrial Mechanics

Today's graduate will enter a job market that is already saturated with a surplus of workers. Only those industrial mechanics students who have been exposed to specialized training, specifically in electronic analysis and application, and who possess excellent skills in communication—reading comprehension, technical writing, and oral expression—can expect to successfully compete for the limited job openings anticipated from 1986 to 1988.

The Oregon Employment Division forecasts industrial employment in 1986 at 32,919 jobs, which includes 1,712 new openings in the state. The 1988 forecast is somewhat higher—34,605 employed, with 1,788 new openings anticipated. The unemployment rate among industrial mechanics for 1983 was 15.7 percent; however 1984 reflected a slightly lower unemployment rate of 12.6 percent.

Data from the 1984 State of Oregon Labor Market Information report is presented here to establish forecasts for employment conditions and job openings for 1986 and 1988 for each Classification of Instructional Program (CIP) within the Industrial Mechanics Cluster Program.

Automotive Vehicle/Accessory Marketing: Reasonable employment opportunities do exist although there is a surplus of workers in this field. Job openings are anticipated to rise from 52 in 1986 to 55 in 1988.

Mechanical Engineering & Technology: Reasonable employment opportunities are expected to exist. Presently, there is a balance of workers. Job openings are expected to rise from 227 in 1986 to 237 during 1988.

Business Machine Repair: Employment opportunities are reasonable. There is presently a balance of workers for this area. The job openings are expected to be limited to 64 in 1986 and 67 in 1988.

Heating and Cooling Mechanics: Reasonable employment opportunities do exist; however, there is a surplus of workers at present. Openings are forecasted to be a modest 92 in 1986, increasing only to 97 in 1988.

Heavy Equipment Maintenance: Even though there is a surplus of workers, the demand is large enough to create reasonable employment opportunities for experienced and highly trained workers. Workers in this CIP have the largest number of job openings available to them. There is a forecast of 717 openings in 1986 and 748 in 1988.

Aircraft Mechanics: This discipline commands the lowest number of persons employed as well as the lowest number of openings forecasted in this CIP. Reasonable employment opportunities do not exist due to small demand and high unemployment. It is anticipated that there will only be 24 openings in 1986 and that in 1988 only 25 openings will be available.

Automotive Mechanics: Although there is a surplus, the demand is large enough to produce reasonable employment opportunities for trained workers. Openings are expected to rise from 409 in 1986 to 427 in 1988.

Diesel Engine Mechanics: Although there is a surplus of workers, the demand is large enough to make reasonable employment opportunities for trained workers. Job openings are expected to rise from 127 in 1986 to 132 in 1988.

Mechanics and Repairers (Includes Small Engines): Reasonable employment opportunities do exist, although there is a significant number of surplus workers in this CIP. The forecasts for this CIP are not available for this report, however present indications are that the ratio of unemployed to openings is four to one. The unemployment rate for instrument mechanics is only 2 percent, whereas many of the other occupations are experiencing high unemployment rates.

Although there is currently a surplus of workers, several factors indicate a positive future in terms of job opportunities. Many heating and cooling technicians are self-employed as independent businessmen. The same is true for small engine and recreation vehicle repairers. Nationwide, 40 percent of currently employed diesel mechanics are over 50 years old. Competent replacement technicians must be prepared. Over the long run, industry is very much concerned about having an adequate supply of highly skilled workers. Thus, it is more important than ever before to evaluate the training offered in the Industrial Mechanics Cluster. To prepare students for the future, all educators must understand where that future lies.

Equipment Needs

The technical committee was requested to make recommendations on equipment needed in the Industrial Mechanics Program, beyond the basic tools and shop equipment. The members were also requested to list equipment they considered to be obsolete.

Several members cautioned against buying expensive, sophisticated diagnostic or front end alignment equipment. This work often is farmed out to specialty shops. They also stated that a person who just completed training at the secondary or community college level would seldom be assigned to a specialty area requiring knowledge of such sophisticated equipment.

The committee recommends

- Good quality volt-ohm meters.
- Equipment that can teach basic principles such as portable front end alignment equipment.
- Air-cooled engine service equipment.
- A hydraulics demonstrator.
- An air-conditioning testing and charging device.
- A brake-disc lathe.
- An alternator and battery test device.

The equipment considered to be obsolete is

- Boring bars.
- Alignment boring tools.
- Crankshaft straightening and connecting rod-alignment tools.
- Diesel pump and injector-testing instruments.

Subject Matter Changes

The technical committee was requested to evaluate current subject matter in industrial mechanics. The following chart illustrates their judgment and indicates the relative importance they gave each subject matter item. A zero represents total obsolescence of the subject matter item and a five means maximum importance. The majority of the committee indicated that all of the subject matter material is valid. The committee also listed their recommendations for future requirements, which are summarized at the end of the chart.

	(1) SUBJECT MATTER ITEM	(2) RELATIVE IMPORTANCE RATE 0 - 5
1.0	SCIENCE	4
2.0	MATHEMATICS	4
3.0	REPAIR &/OR OVERHAUL	
3.1	Belt & chain drives	
	a) Shafts	3
	b) Bearings	3
	c) Couplings & clutches	3
	d) Gears	3
	e) Angular geometry & mechanical linkage	2
	f) Lubrication	4
3.2	Electrical systems	
	a) Voltmeter	4
	b) Ohmmeter	4
	c) Ammeter	4
	d) Oscilloscope	3
	e) Symbols and schematics	4
	f) Circuitry	4
	g) Magnetism	2
	h) Batteries	3
	i) Diodes	3
	j) Coils/condensers/ distributors	3
	k) Cranking motors	3
3.3	Fluid power systems	
	a) Safety	4
	b) Fluids	3
	c) Cleaning devices	3
	d) Filters and strainers	3
	e) Symbols/pictorials/specs	3
	f) Basic circuits/theory operations	4
	g) Component identification	3
	h) Component manipulation, assembly/disassembly	4
	i) Performance testing	4
4.0	HAND TOOLS	
4.1	Metal working tools	3
4.2	Portable power tools	3
4.3	Mechanics tools	4
4.4	Specialty tools	3

	(1) SUBJECT MATTER ITEM	(2) RELATIVE IMPORTANCE RATE 0 - 5
5.0	MACHINE TOOLS	
5.1	Engine lathe	2
5.2	Drill press	3
5.3	Grinder/hone	3
6.0	WELDING	
6.1	Oxy-acetylene gas	3
6.2	Electric arc	3
6.3	Soldering	3
7.0	HOISTS AND JACKS	
7.1	Floor hoists	3
7.2	Fluid power lifting devices	3
7.3	Overhead lifting units	3
8.0	MEASURING	
8.1	Manipulate and interpret	
	a) Micrometers	4
	b) Dial indicators	4
	c) Feeler gauges	4
	d) Calipers	4
	e) Spring scales	2
8.2	Read and interpret	
	a) Pressure gauges	4
	b) Hydrometers	3
	c)Temperature gauges	3
	d) Compression gauges	3
9.0	COMMUNICATIONS AND COMMUNICATIVE DEVICES	
9.1	Communication theory	3
9.2	Inspection data	3
9.3	Secifications	3
9.4	Equipment operation instruction	3
9.5	Work charts	2
10.0	MAINTENANCE TECHNIQUES	
10.1	Engine noise diagnosis	3
10.2	Engine tune-up	4
10.3	Visual inspection	4
10.4	Vehicle basic activation	3
10.5	Cleaning of equipment components	3
10.6	Tolerances, clearances and torquing	4
10.7	AC/DC electrical systems	4
10.8	Cooling systems	4

	(1) SUBJECT MATTER ITEM	(2) RELATIVE IMPORTANCE RATE 0 - 5
11.0	SURFACE FINISHING	
11.1	Touch-up painting	1
11.2	Polishing and buffing	1
12.0	SAFETY (Infused training)	
12.1	Shop inspection	4
12.2	Machine operation method	4
12.3	Safe use & storage of	
	a) Flammable liquids	4
	b) Caustic materials	4
	c) Cleaning equipment	4
12.4	First aid	5
13.0	JOB READINESS	
13.1	Application techniques	4
13.2	Interview techniques	4
13.3	Career knowledge	5
13.4	Grooming, attire	4
13.5	Job retention/advancement	5
13.6	Resume	4
14.0	ENTREPRENEURSHIP	
14.1	Management practices	3
14.2	Tax considerations	2
14.3	Property ownership	1
14.4	Customer relations	4
14.5	Advertising	1
15.0	LEADERSHIP SKILLS	
15.1	Customer relations	5
15.2	Introducing people	3
15.3	Group behavior	2
15.4	Planning activities	2
15.5	Speaking to groups	2

Recommendations for Subject Matter Evaluation

The committee offered these recommendations:

1. Teach science and math with much closer application to the physical reality of industrial mechanics. Use practical problems in mechanics as the vehicle for teaching science and math.

2. Strongly emphasize competency in reading, writing, and oral expression.

3. Provide more concentrated study of electrical systems. Some members indicated that education lags in this area. Solid state electrical ignition principles and repair need to be part of instruction.

4. Include training for gas metal/tungsten and shielded metal arc welding. Also, provide training for welding plastics and non-ferrous metals.

5. Maintenance techniques should remain basic since each manufacturer uses different specifications for power equipment.

6. Reliability, promptness, loyalty and other positive personal attributes should be taught and reinforced for optimal employer and employee relationships.

7. Stress importance of customer relationships.

8. Specialty tool instruction should include operation of special reamers and test equipment for small engines.

9. Include industrial and automotive safety systems under reading and interpreting.

The committee also suggested future requirements for subject matter items to be taught during the next five years. They include

1. Servo mechanisms,
2. Hydrostatic transmissions,
3. Basic electronics and computer logic,
4. Basic robotic principles, operation, and maintenance,
5. Fuel injection and turbo charging, and
6. Water- and air-cooled diesel engine introduction and applied theory.

Essential Learning Skills

Young people make the transition from school to work through a variety of means and circumstances. For some, the transition to a practicing career is done because of goal-oriented planning; for others, the transition may be by happenstance. Not too many years ago, the direction for a person's future work was determined principally by where he or she lived, the occupation of the father, and occupations of acquaintances and others. These provided sufficient exposure to jobs. Youth flowed fairly smoothly into the labor force.

Today, however, the transition for high school youth into the labor market is difficult. So is the transition for adults from obsolete occupations into different ones. In the years ahead, this transition promises to become more difficult because of major changes in the work force. These major changes will involve such factors as dual-career families, the impact of use of computers, the anticipated increase in white collar workers, a surplus of college graduates in relation to their job preparation areas, an increasing mismatch of skills and jobs, a growth in low-paying jobs, and an aging labor force.

A Lifetime of Learning

Thus, it becomes critical that students have the opportunity for further education and training so they can adapt to changes in society and their careers. Schools therefore must somehow prepare students to consider continuing education a viable and, in some cases, essential way to remain marketable in an increasingly competitive workforce.

Essential learning skills are those that individuals must master if they are to continue to grow, learn, and adapt to change. They are not unique to any one subject area; rather students must learn them in order to help them acquire any other knowledge and skills. They consist of reading, writing, mathematics, listening, speaking, study skills, and reasoning, including critical thinking and scientific method.

The Importance of Basic Skills

Employer studies, reports and articles all show that these skills are important. Writing and speaking skills are ranked first in employers' views of areas needing improvement. Acquisition of skills to read printed matter required for jobs ranked fifth. With 90 percent of the work force of 1990 already in the labor market and with an estimated 10 million workers identified as functionally illiterate, change seems to be the order of the day. Mastering basic, essential skills to equip future workers for change is an important outcome of modern vocational education.

Concerned Oregonians are evaluating the Essential Learning Skills publication. By reviewing a preliminary copy, action can be taken to produce an improved vocational cluster program. The Department's Curriculum Director is prepared to furnish information and progress reports upon request for this important phase of the Action Plan for Excellence.

The following outline of performance standards for essential learning skills represents the range of skills that vocational teachers can teach and reinforce as they perform subject matter updating.

Students will be able to

1. **Demonstrate use of vocabulary, speech, numerals (figures, letters, words) and other appropriate symbol systems essential for effective communication, computation and problem solving**

   1.1 Recognize words commonly used in grade-level materials

   1.2 Determine meaning of unknown words commonly used in grade-level materials

   1.3 Speak with standard pronunciation, appropriate volume, rate, gestures and inflections

   1.4 Use number/numeric figures, letters, words, symbols, concepts to count, compute and communicate quantitative data

   1.5 Recognize and use geometric patterns, relationships and principles to describe and classify

   1.6 Recognize and use mathematical patterns, relationships and principles to quantify problems or make predictions

   1.7 Estimate and measure quantities, areas and objects; define problems, develop hypotheses, select appropriate methods of computation, solve problems

2. **Interpret the literal meanings of information in written, visual and/or oral communication**

   2.1 Identify main ideas, supporting details, facts, and opinions presented in written, oral and/or visual formats

   2.2 Use instructional materials as basis for gaining knowledge and/or improving comprehension

   2.3 Use oral communication to give/receive information and/or directions

3. **Interpret the implied meanings of information presented in written, oral and/or visual communications**

   3.1 Comprehend implied meanings of written and oral communication

   3.2 Use oral communication to imply meanings and convey ideas, feelings, attitudes

4. **Evaluate content and use of oral, audio and visual communications**

   4.1 Make judgments about the significance and accuracy of information and ideas presented in written materials

   4.2 Use oral communication to respond to others' efforts to persuade and/or to influence others' beliefs and actions

   4.3 Listen with discrimination to the sounds of nature, language, music, and environment

   4.4 Listen, read, view presentations of mass media with discrimination

5. **Generate, organize, express, and evaluate ideas in oral, written, or visual forms**

   5.1 Use a variety of techniques to generate writing and speaking topics (prewriting)

   5.2 Organize ideas in understandable sequence: introduction, body, conclusion; problem solving; spatial, chronological or topical (prewriting/planning)

5.3 Select appropriate form of writing based on audience and purpose

5.4 Present ideas in understandable sequence on the topic selected (drafting)

5.5 Use language, gestures, symbols appropriate to audience, purpose, topic and setting to convey oral information (making oral presentations)

5.6 Evaluate and revise own writing for meaning, clarity, and comprehensiveness (revision)

5.7 Apply the conventions of writing to produce effective communication (editing and proofreading)

6. Plan and carry out problem-solving strategies related to varied assignments in an organized and systematic manner

6.1 Use problem-solving strategies to address varied assignments

6.2 Select most appropriate tools, methodologies, processes, operations in solving problems related to varied assignments

7. Manage time, instructional resources, and personal habits and attitudes constructively in order to accomplish learning tasks

7.1 Clarify purposes of assignment

7.2 Use resources beyond the classroom

7.3 Use study techniques

7.4 Use reading rate appropriate for assignment

7.5 Follow a study plan

7.6 Keep study materials organized and accessible

7.7 Maintain appropriate physical and emotional practices

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